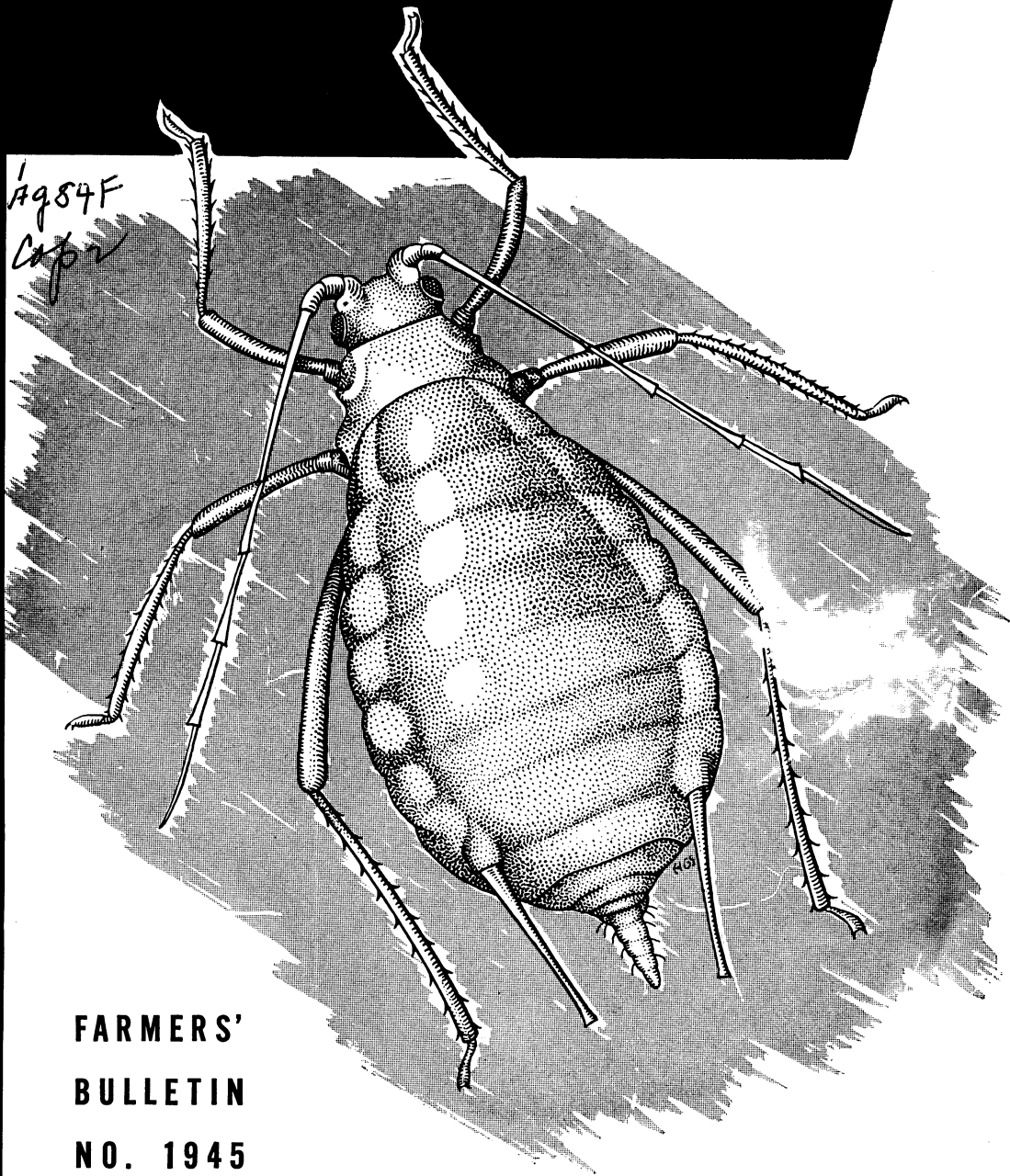


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The PEA APHID on PEAS and methods for its control



FARMERS'
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U. S. DEPARTMENT OF AGRICULTURE

THE PEA APHID destroys more peas in the United States than any other insect that attacks this crop. Natural enemies cannot be depended on for its control; therefore insecticides must be applied.

This bulletin tells you which insecticides are best for use in different parts of the country. It also tells you how and when to apply sprays or dusts containing these insecticides.

For best results use good equipment and apply the spray or dust before any damage occurs.

Some of the insecticides discussed here, particularly parathion and TEPP, are extremely poisonous. If you use them, be sure to follow carefully the special precautions recommended by the manufacturer.

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THE PEA APHID ON PEAS and Methods for Its Control¹

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THE PEA APHID⁴ is one of the most destructive insect enemies of peas in this country. It is now in every State of the Union and in several Provinces of Canada. At one time or another it has been reported as an important pest in 25 States scattered from Maine to California and from Washington to Florida; in 13 of these States it is a serious pest every year.



The pea aphid is especially destructive when it infests pea pods.

¹ This bulletin includes information obtained by the Bureau of Entomology and Plant Quarantine in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering, several experiment stations, canners, and growers.

² Retired October 31, 1951.

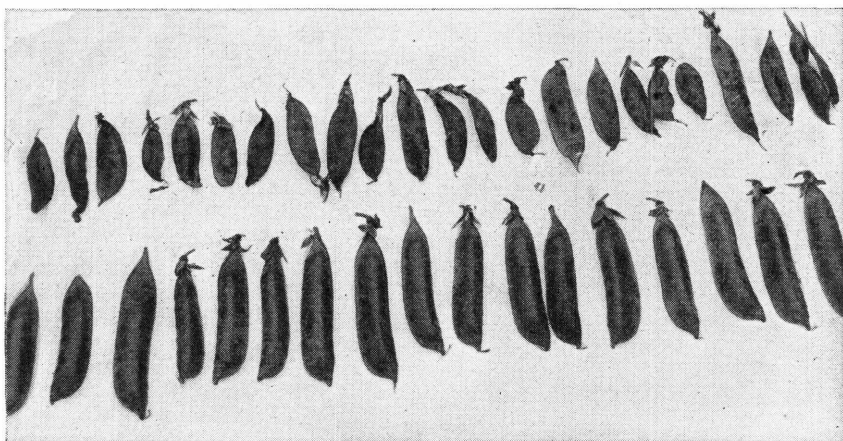
³ Resigned January 31, 1952.

⁴ *Macrosiphum pisi*.

INJURY CAUSED BY THE PEA APHID

The pea aphid sucks the sap from the leaves, stems, blossoms, and pods of the plants on which it feeds. It multiplies so rapidly under favorable conditions that a light infestation may increase to alarming proportions in less than a week. A few aphids may kill pea plants less than 6 inches high, but cause only slight injury to much larger plants. The damage may range all the way from a small reduction in yield to complete loss of the crop.

Plants on which aphids feed become stunted and produce fewer and smaller pods than uninfested plants. Aphids may also feed on the pods, causing them to curl, shrink, and to be only partly filled with peas. Such deformed pods have a low market value, and when



Pea pods injured by aphids (upper row); uninjured pods (lower row).

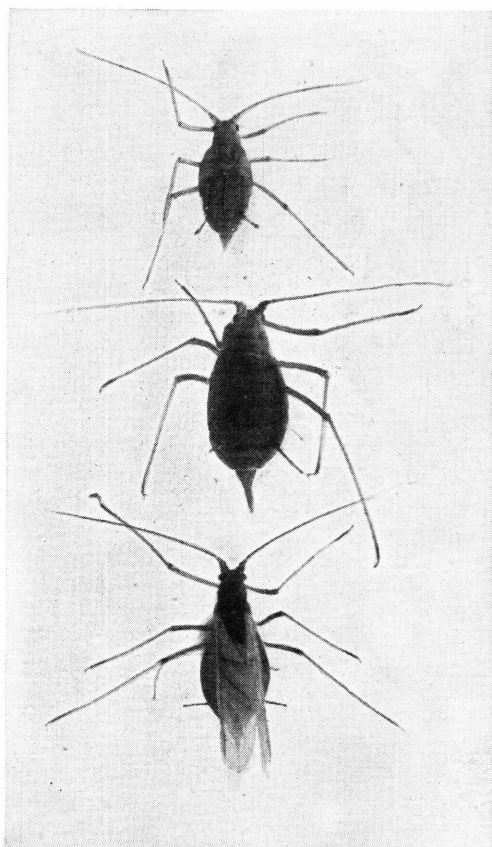
harvested by mechanical means do not shell out in the viner. Often, plants infested with aphids do not mature uniformly, so that the harvested peas vary in quality. Injury of this type alone is usually sufficient to justify treatments.

The pea aphid also transmits several virus diseases to pea plants. These diseases are more critical in the Pacific Northwest than in other sections of the country. One of the most important, often referred to as yellow bean mosaic, is widespread in alfalfa. It may also cause severe losses to peas in seasons when large numbers of aphids move from alfalfa to peas. Another virus disease, known as enation mosaic, may appear late in the season. Infected pods become tough and difficult to shell out mechanically, and the quality of the peas is lowered. Other less important viruses occur commonly in alfalfa and peas in the West.

The acreage of peas upon which threatening aphid infestations develop varies from year to year, but it is usually necessary to treat substantial acreages with insecticides every year. For example, in 1948, of the 126,000 acres of canning peas grown in Wisconsin, 90,000 were treated for pea-aphid control, at an estimated cost of \$590,000. From 1940 to 1944 the pea aphid caused an average annual loss to the pea crop in the United States estimated at nearly 4 million dollars.

HOW TO RECOGNIZE THE PEA APHID

The pea aphid is a light-green insect nearly $\frac{3}{16}$ -inch long and one-third as wide. Except in size, the young, or nymphs, look just like the adults. Most of the aphids are wingless, although some individuals with wings can nearly always be found.



Nymph

Wingless adult female

Winged adult female

The pea aphid. (Enlarged.)

HOST PLANTS

Peas are the most widely distributed and the most-favored food plants of the pea aphid. All peas are attacked by this insect, whether they are grown as green peas for market, for canning or freezing, for seed, as field peas, as sweetpeas grown for their flowers, or inedible Austrian winter peas grown as a cover crop. Every State grows peas for one or another of these purposes. The commercial planting of edible peas in 1949 was approximately 420,000 acres.

Peas are grown both for canning or freezing in at least 31 States, but the industry is confined largely to the areas around the Great Lakes and to Washington and Oregon. These areas, especially around the Great Lakes, also grow large acreages of alfalfa and clover. Such

perennial crops serve as reservoirs for the aphid during that part of the year when peas are not being grown.

Alfalfa ranks next to peas as the favored host of the aphid. Serious infestations may develop on this crop in some States, notably in Kansas and California. About 18 million acres of alfalfa were grown in the United States in 1949.

The pea aphid also feeds on vetch and several kinds of clover, including red, alsike, crimson, and sweetclover, but it seldom damages these plants seriously.

HOW THE PEA APHID LIVES

Infestations of the pea aphid in peas begin early in the spring with the migration of winged aphids from alfalfa and clover. After reaching the peas they reproduce rapidly. The females give birth to living young, all females. One female may produce as many as 10 to 14 young in 1 day; hence a heavy infestation can develop from a few winged forms. As the young aphids grow they shed their skins, or molt, four times, and in about 10 days become wingless adults. In heavy infestations many thousands of these molted skins collect in whitish piles on the ground beneath the plants, and are sometimes mistaken for dead aphids. As peas approach maturity and become less favorable for feeding, winged aphids again appear. Although most of them die, some find their way back to alfalfa and clover.

In the South the pea aphid remains active most of the winter and continues to produce living females. In the northern part of the country, males and egg-laying females develop sometime in the fall. The males are usually winged and the females wingless. Eggs are able to survive low temperatures that kill all other forms, although in some areas all forms may survive mild winters. These shining-black eggs are glued to the stems and fallen leaves of alfalfa and clover. In April or May, depending upon the latitude, the eggs hatch into young aphids.

Winged aphids do not appear until the second or third generation. By the time alfalfa and clover bloom, most of the aphids have developed wings. These winged aphids make their way to peas to form the initial infestation on this crop. Heavy infestations on peas may thus be expected where large acreages of alfalfa or clover are grown. However, peas many miles from any alfalfa may become infested, as winged aphids often are carried long distances by air currents.

NATURAL ENEMIES

A number of natural enemies check aphid development and often prevent serious outbreaks. The most important are predatory and parasitic insects and diseases caused by fungi and bacteria. These enemies, especially the insects, can become abundant only when the aphids on which they feed are numerous.

WHEN TO APPLY INSECTICIDES

To control the pea aphid insecticides are necessary, for natural enemies and cultural practices cannot be counted on to prevent damage.

Apply insecticides before the aphids have become sufficiently abundant to damage the peas. A convenient method of measuring the infestation is to make single half-circle sweeps with a collecting net in five representative parts of a field and count the aphids captured. Do this when the plants are dry. Use a net about 15 inches in diameter and having a handle 2 or 3 feet long. Make each stroke heavy enough to knock into the net a large proportion of the aphids present but not so heavy as to injure the plants.

If you collect 30 to 40 aphids in one sweep, or find 1 aphid per plant, on plants too small to sweep, treat at once. Insecticides applied when the infestation is light give best control. Examine treated fields frequently. If one application does not keep the aphids in check, make a second one.

Some varieties of peas develop buds that are shaped like clam shells. Aphids feeding within these buds are difficult to reach with insecticides. Therefore, apply them before the buds are formed.

WHAT INSECTICIDES TO APPLY

The insecticides and methods of application recommended for control of the pea aphid vary in different parts of the country because of certain basic differences in climate and in cropping practices. The Pacific Northwest has more sunshine and wind and less humidity, with consequent faster evaporation than is general in the East and Middle West.

In the relatively humid areas of the East and Middle West, three types of insecticides will control the pea aphid if properly applied: (1) Organic-phosphorus insecticides such as parathion and TEPP; (2) those containing DDT or related chemicals; and (3) those containing rotenone derived from derris or cube. Nicotine may also be used, but at temperatures below 70° F. its performance is uncertain. In recent years it has been largely replaced by the other materials listed above.

In the semiarid areas of the Northwest, a large number of insecticides have been tested, but only parathion, TEPP, and DDT have been generally effective. Rotenone and nicotine, either with or without accessory materials, have proved of little value.

These insecticides may be applied as dusts, sprays, or liquefied-gas aerosols. Both dusts and sprays may be applied either by ground equipment or by aircraft, but aerosols must be applied with ground dispensers. In the Northwestern States sprays are applied almost entirely by airplane. In the Eastern and Central States, both aircraft and ground sprayers are used.

Some insecticides, such as nicotine and TEPP, exert their full toxic action during the first few hours. Others, such as parathion, DDT, and rotenone, continue to kill for several days as aphids come in contact with the insecticide adhering to the foliage. This prolonged killing property is known as residual effectiveness.

PRECAUTIONS

All the insecticides discussed in this bulletin are poisonous to man and animals, but with care they can be handled safely at the strengths suggested for pea aphid control.

Store them in plainly labeled containers and use them cautiously. Do not let oil solutions or emulsions come in contact with the skin, especially when handling concentrated material. Do not inhale any dust or spray while mixing or applying it. Do not use oil sprays near fires or allow smoking near mixing and storage tanks.

TEPP and parathion are violent poisons and should be used only when a trained operator is available to assume full responsibility and to enforce the precautions prescribed by the manufacturers. **These insecticides are extremely toxic if swallowed, inhaled, or absorbed through the skin, and may cause death.**

A person mixing or applying TEPP or parathion should observe special precautions. His shirt should be buttoned at the neck and the sleeves rolled down and buttoned at the wrist. He should wear hat, or cap, rubber-covered gloves, and overalls or rubberized coat or apron that can be washed after each exposure to the insecticide. He should also wear a respirator equipped with a canister specified for use in handling organic vapors and dusts; the canister should be replaced with a new one after use. He should wear goggles that give a tight seal with the respirator around the nosepiece. Respirators do not protect persons mixing these insecticides in closed or poorly ventilated spaces. Full-face gas masks equipped with suitable canisters should be worn under these conditions.

A person developing headache, nausea, impaired vision, or tightness of the chest when using parathion or TEPP should go or be removed to fresh air immediately. He should be given an emetic, such as mustard or warm soapy water, and a doctor should be called. **Atropine sulfate is an antidote for these poisons.** It may be obtained by prescription in 1/100-grain tablets and kept on hand for emergency. **For severe poisoning two tablets should be taken at once and a doctor called immediately.** Atropine is not a preventive, for it will give no protection against subsequent exposure to parathion. Atropine itself is a dangerous poison.

ROTENONE

Rotenone applied at the strengths recommended in this bulletin leaves no objectional residue on pea ensilage used as livestock feed. It is not hazardous to the operator when handled with ordinary precautions. It is slower acting and not quite so effective as parathion, TEPP, or DDT, but will give reasonably good results if properly applied. It continues to kill aphids for 3 to 5 days after application.

Dusts should contain at least 1 percent of rotenone and at this strength be applied at the rate of 35 pounds per acre. Their effectiveness will be increased if 1 or 2 percent of a light mineral oil is added. As oil-conditioned dusts deteriorate on long storage, buy no more than is needed for the current season. Ready-prepared dusts are sold under various trade names. Directions for use can be found on the package and should be followed carefully.

Rotenone sprays may be made from emulsifiable concentrates as recommended by the manufacturer. The ground root of derris or cube may also be used in preparing a spray, but a spreading or wetting agent must be added. The quantity of powder needed depends on the rotenone content. For example, use $2\frac{1}{2}$ pounds per acre of a powder containing 5 percent of rotenone. Add this amount to 10 to 15 gallons

of water for concentrated sprays and to 100 to 150 gallons for dilute sprays. Make a smooth paste of the ground root and a little water containing the wetting agent, as recommended by the manufacturer, and then add this paste to the rest of the water. Be sure that the spray mixture is constantly agitated in the tank. Use nozzles having holes large enough to prevent clogging.

DDT

DDT kills aphids more quickly than rotenone and is effective longer. DDT residues remaining on the foliage will kill the aphids for a week or more.

DDT has been found in the milk and fat of animals fed pea ensilage. Therefore, do not feed ensilage from DDT-treated plants to milch animals or to animals being finished for slaughter.

DDT dusts may be used with or without a nonvolatile oil conditioner, but its addition increases the effectiveness of a dust. For example, the addition of 2 percent of methylated naphthalene to a dust containing 2 to 3 percent of DDT makes it as effective as one containing 5 percent of DDT without this oil. Apply these dusts at the rate of 35 pounds per acre. A dust containing 2 to 3 percent of DDT conditioned with oil is recommended for use in the Eastern and Central States, and a 5-percent DDT dust in the Northwestern States.

In the Northwest the value of DDT dusts may be greatly increased either by using a diluent containing 50 to 85 percent of sulfur or by the addition of 1 to 2 percent of a nonvolatile oil. As sulfur may injure peas under moist conditions, do not apply it to peas in humid areas.

In the Eastern and Central States, DDT sprays for application with ground equipment should be prepared from emulsifiable concentrates. Those containing wettable powders are much less effective against the aphids. Emulsifiable concentrates prepared with the wrong solvents may cause serious foliage injury. Xylene has generally been found to be the most satisfactory solvent. Choose a reliable concentrate that has been thoroughly tested on peas, and use it as recommended by the manufacturer. Dilute the concentrate with water so as to apply 1 pound of actual DDT per acre in 10 to 15 gallons for a concentrated spray or in 100 to 150 gallons for a dilute spray.

For aircraft spraying in the Northwestern States, a solution of 4.5 to 5 percent of DDT in light oil has been very effective when applied as a moderately coarse spray at the rate of $3\frac{1}{2}$ to 5 gallons per acre. This spray may cause some injury to the plants, but the effect upon either the yield or the quality of peas has usually been too small to detect. Such injury has been most noticeable on plants sprayed in full bloom or on those infected with a mosaic virus. Wettable-powder water sprays are not effective against the aphid in this region. DDT emulsions have not been tested.

TEPP

TEPP will control the pea aphid, but it is a very poisonous chemical and should be used only by experienced operators. (See precautions on p. 6.) It decomposes rather rapidly after application and therefore has practically no residual effectiveness. As it leaves

no poisonous residue on the foliage at harvesttime, it is very useful for controlling the aphid on peas nearly ready for harvest.

Use a ready-mixed dust containing 1 percent of TEPP at the rate of 35 pounds per acre. Since it deteriorates rapidly, it should be mixed by the dealer shortly before use. The entire bag or drum of dust should be used on the day it is opened.

To prepare a TEPP spray, add 1 quart of a 20-percent or 1 pint of a 40-percent concentrate to sufficient water to make 10 to 15 gallons of a concentrated spray or 100 to 150 gallons of a dilute spray.

Concentrated sprays have sometimes caused foliage injury in the Eastern and Central States. This tendency may be partially overcome by using nozzles that give a fine spray. No foliage injury has been observed after the use of dilute sprays.

TEPP sprays applied by aircraft should be used at the rate of 6 to 10 gallons per acre. Small dead spots on pea leaves are often seen following the use of this spray, particularly on diseased plants, but no reduction in yield or quality of peas has been detected.

PARATHION

Parathion is another highly poisonous insecticide that is very effective against the pea aphid. (See precautions on p. 6.) It remains effective on the foliage much longer than TEPP but not nearly so long as DDT. To avoid danger of poisonous residues on the foliage, do not apply parathion within 10 days of harvest.

Do not attempt to prepare parathion dusts. Use a ready-mixed dust containing 1 percent of parathion at the rate of 35 pounds per acre.

Parathion sprays may be prepared from either wettable powders or emulsifiable concentrates. For application with ground equipment in the Eastern and Central States, use one-fourth to one-third pound of actual parathion per acre in 10 to 15 gallons of water for concentrated sprays or in 100 to 150 gallons for dilute sprays. If you use a wettable-powder spray, be sure to maintain continuous mechanical agitation.

For application by aircraft in the Northwestern States, use 1½ pounds of a 25-percent wettable powder or 1½ pints of a 25-percent emulsifiable concentrate in 4 or 5 gallons of water per acre. Some spotting of the leaves and pods has been observed after application of emulsion sprays, but usually it is of minor importance.

HOW TO APPLY INSECTICIDES

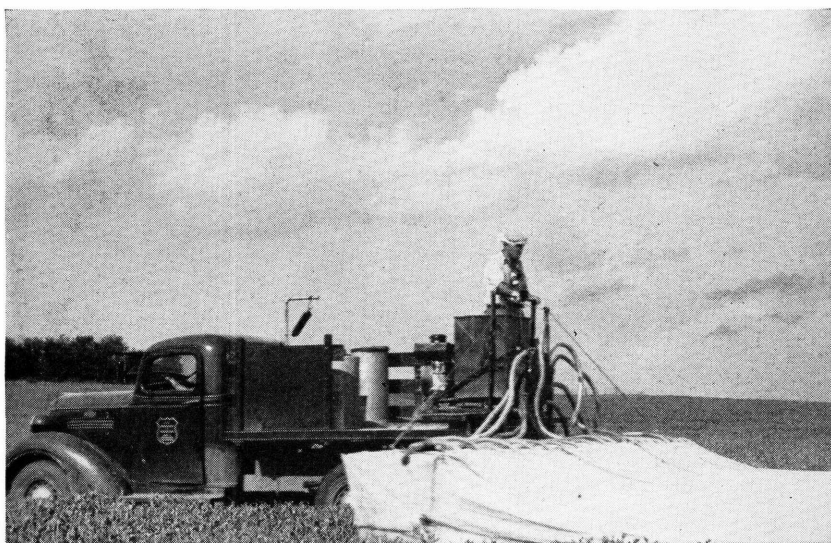
The degree of control obtained with any of these insecticides depends on the use of proper equipment and thoroughness and timeliness of application.

Ground equipment is often preferred if applications are made before peas have blossomed. It causes slight injury to the plants growing in the path of the wheels. Measurements during a 3-year period showed that the damage caused by a truck with single 6-inch tires carrying a dusting machine with a 24-foot boom ranged from 2 to 4 percent in weight of marketable pods. Ground equipment should be operated at not more than 3 to 4 miles per hour.

Aircraft application is more desirable when the crop is nearing maturity and when the soil is wet. It is particularly convenient when large acreages must be treated in a short time. Aircraft application of insecticides, especially dusts, should be attempted only in calm or nearly calm weather. It is generally unsatisfactory in small, hilly fields or in those bordered by trees, buildings, or power lines.

GROUND DUSTING

Use a power duster capable of developing sufficient air velocity to produce a fine dust cloud and drive it well into the plants. Adjust the nozzles just far enough above the plants so that they will distribute the dust uniformly. If possible, enclose the front and ends of the boom with canvas, and attach to the boom an apron or trailer 25 or more feet long, made of canvas or muslin. This equipment is of particular value when you are driving into a wind. Do not



Power duster with apron. The boom is entirely enclosed, and the apron prevents excessive dust drift.

use the apron if the plants are wet with dew or rain; it will become watersoaked and damage the foliage. Usually under such conditions there is little wind. When the wind velocity is higher than 10 miles per hour best results cannot be expected, even with an apron.

In the Northwestern States it has been found that a semicircular metal hood extending the entire length of the boom is just as effective as an apron. The hood may be adjusted so as barely to touch the plants, whereas the apron must be dragged over them.

For maximum efficiency of operation be sure that (1) the dust contains the recommended strength of toxicant, (2) the dust is being discharged uniformly from the different nozzles of the boom and the required amount per acre is being delivered, (3) the rate of delivery is checked when the type or brand of dust is changed, (4) the boom is at the proper height above the plants, and (5) the wind velocity is low.

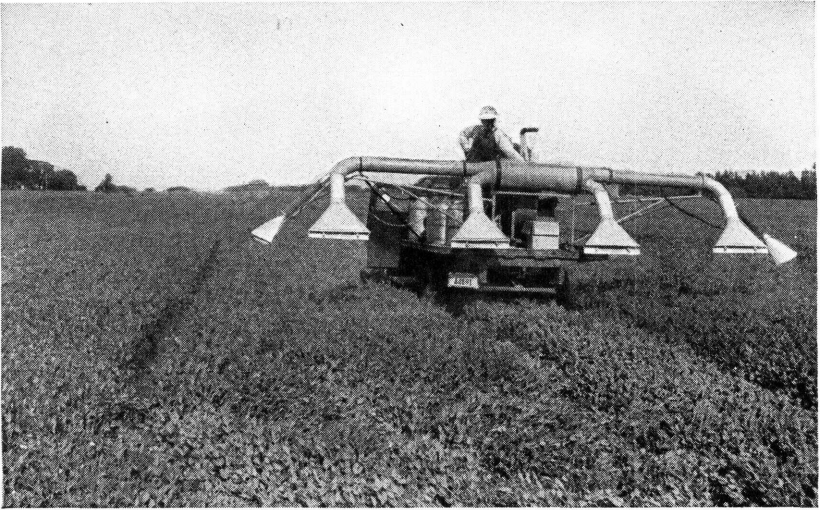
GROUND SPRAYING

Two types of sprays may be applied from the ground, dilute high-gallonage sprays and concentrated low-gallonage sprays. The same quantity of insecticide per acre is applied by either method.

Apply dilute sprays with conventional sprayers operating at a pressure of 300 pounds per square inch, at the rate of 100 to 150 gallons per acre. Adjust the boom high enough so that the spray cones from adjacent nozzles meet before hitting the tops of the plants. It is important to strain the spray water and to examine the nozzles frequently to make certain that all are operating. A tank wagon or truck should be provided for hauling water.

Apply concentrated sprays at the rate of 10 to 15 gallons per acre, with weed-type sprayers modified for application of insecticides and operating at 40 to 75 pounds' pressure.

The loaded sprayers for applying dilute sprays are much heavier than those for applying concentrated sprays and therefore cause more mechanical injury to the crop, particularly in wet clay soils. The large quantities of water needed entail extra costs for labor and equipment.



Mist blower for applying concentrated sprays. The fine mist is forced among the plants by a large volume of air under pressure from a heavy blower fan.

If you prefer, you can apply concentrated sprays with a mist blower. In this new type of equipment the spray is forced through special nozzles at 75 to 100 pounds' pressure and is further broken up and driven into the foliage by a strong air blast produced by a blower fan. Approximately 10 gallons of spray per acre should be applied with this apparatus.

Since concentrated sprays contain a relatively high percentage of toxicants and solvents, they are more likely to injure foliage than are dilute sprays. Therefore, a variation of even 2 or 3 gallons per acre may give inferior control if the application is too light, or injure

the foliage if too much is applied. Concentrated sprays must be broken up into a fine mist with fog nozzles or mist blowers and distributed uniformly to prevent the accumulation of excessive residues on the foliage.

If the sprayer has been used to apply weed-killing sprays, clean it thoroughly before applying insecticides. Rinse it with clean water and then fill it with a 1-percent solution of household ammonia (2 teaspoonfuls per quart of water). Leave the solution in the spray tank, booms, and hoses for 12 to 24 hours; then remove and rinse with clean water. Do not use sprayers with wooden tanks for both weed control and aphid control, because it is practically impossible to remove 2,4-D from wooden tanks.

USE OF AEROSOLS

Aerosols do not require pumps or blowers for application. The insecticide is mixed with a liquefied gas under pressure in a steel tank, and the gas pressure forces the insecticide through small nozzles as a very fine spray or mist.

Aerosols containing DDT, although effective against the pea aphid, have not provided so high a degree of control or proved so practicable as DDT dusts. Aerosols containing TEPP or parathion have given excellent control, but are extremely hazardous to the operator.

Aerosols offer the advantage of comparatively light equipment, but the cost per acre for materials is generally greater than the cost of dusts or sprays.

AIRCRAFT APPLICATIONS

Aircraft applications of insecticides are usually made by companies specializing in such operations.

Effective spraying and dusting by aircraft require that there be very little air movement.

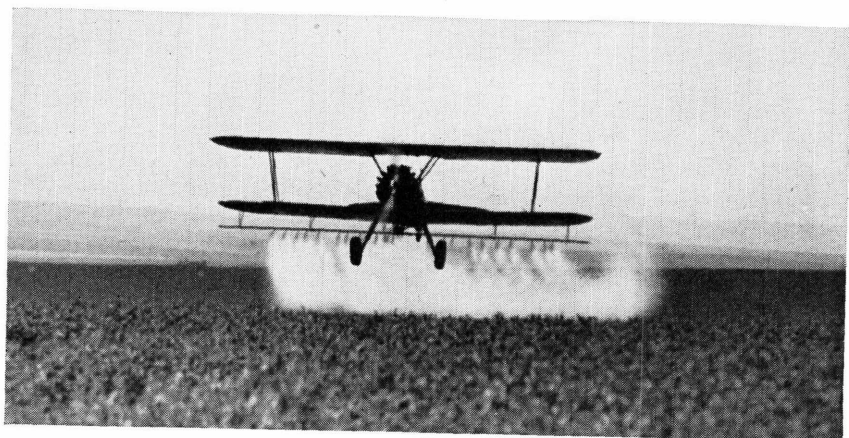
A map should be made of all the fields to be treated in a locality; and if possible a central landing strip should be provided that is suitable for the type of plane being used and from which all fields to be treated are readily accessible.

For spraying, the airplane should be equipped with a boom extending at least three-fourths to the full length of the wing span and having 20 or more nozzles. If suspensions or emulsions are to be applied, a centrifugal pump is preferred. If only solutions are used, a gear pump is satisfactory, but may be subject to considerable wear. The delivery of either type of pump should be adjustable from a minimum of 20 gallons to a maximum of 70 or 80 gallons per minute. With airplanes having a 30- or 35-foot wing span and flying within 4 or 5 feet above the vines, at a ground speed of 80 to 90 miles per hour, from 3 to 10 gallons can be applied per acre over a 45-foot swath.

Each swath should be marked with a flag or stake so that the pilot will not miss any plants, or flagmen may guide the pilot. If very poisonous materials, such as parathion or TEPP, are being applied, the flagmen should be provided with respirators to protect them from drifting dust or spray.

Sprays should be delivered as close to the plants as possible. When applications are made within 4 or 5 feet above the vines, the flagging or marking of the field should be done on the basis of a 45-foot swath, to provide an overlap and prevent skips. For any increase in height of flight there should be a corresponding increase in rate of discharge. For example, swaths for 10-foot heights should be flagged at 55 to 60 feet. Applications for pea-aphid control should not be made at heights of more than 8 to 10 feet.

Dusting by aircraft has greatly increased in recent years in the Eastern and Central States, especially since parathion has been available. In 1950 dusts applied by aircraft were used over approximately three-quarters of the pea acreage treated. In applying dusts in these regions, small planes should fly from 3 to 5 feet above the tops of the plants and larger planes at a height of 5 to 10 feet. The width of the swath should not exceed the wing span of the plane.



Dusting by airplane. It is especially important that the air be calm when dusts are applied.

In the Northwestern States airplane applications of parathion and TEPP dusts, although not so satisfactory as sprays, have been effective when there was no wind. Application of DDT dust by airplane has not been satisfactory. In general, the tendency to treat too wide a swath with too little material has caused uneven and inadequate aphid control. Therefore, until better means of distributing dust from a plane are developed, airplane dusting with DDT cannot be recommended for this part of the country.

PEA-APHID CONTROL IN HOME GARDENS

For controlling the pea aphid in home gardens, use rotenone or DDT dusts or sprays. Do not use TEPP or parathion, for both these materials are extremely poisonous and should be handled only by experienced operators.

Apply rotenone or DDT dust or spray with hand equipment as soon as you see aphids on the plants. It is often desirable to make two or three applications at 7 to 10 days apart. Buy ready-mixed dusts.

For making small quantities of rotenone spray, use $4\frac{1}{4}$ ounces (8 tablespoonfuls or half a cupful) of ground derris or cube root to 3 gallons of water, or one-half ounce (3 tablespoonfuls) to 1 gallon. (All measurements should be level.) Prepare DDT emulsion sprays as recommended by the manufacturer.

Nicotine sulfate dusts and sprays are also effective, provided the temperature is above 70° F. Use a 3-percent dust or a spray containing 1 tablespoonful of 40-percent nicotine sulfate and 2 tablespoonfuls of soap flakes for each gallon of water.

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